Long Jumping Linux 2.6...5.10

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whoami

- Parthiban Nallathambi, Linumiz
  - ✓ Embedded Linux and Zephyr RTOS development, consulting, training
  - ✓ Embedded Linux development: BSP, u-boot, Linux Kernel, Yocto Project, Buildroot
  - ✓ Zephyr: SoC, Board support, drivers
  - ✓ www.linumiz.com
- Living in **Berlin**, Germany

Agenda

- Why to migrate?
- What can be upgraded?
- How to upgrade?
- Key factors to consider
- Build system

Assumptions

- All the IP blocks are supported in U-Boot, Linux Kernel
- No coding required or minor changes
- Custom Kernel out-of-tree drivers and migration aren't considered
- Knowledge about devicetree is assumed and isn't discussed extensively

Why to migrate?

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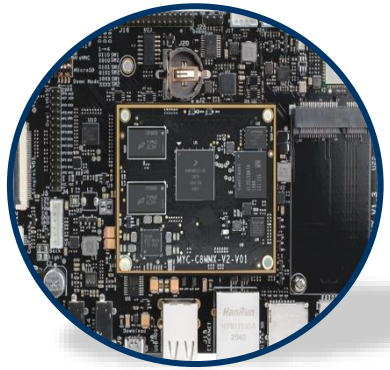
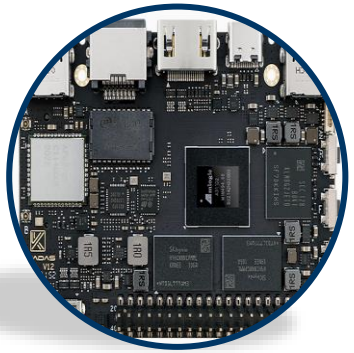
New technology and hardware





New technology and hardware

Product Lead Time Estimates

QUANTITY: 4000 Update

Quantity	Ship Date Estimate
4.000	3/11/2059

Ship dates are approximate and subject to change.

OK

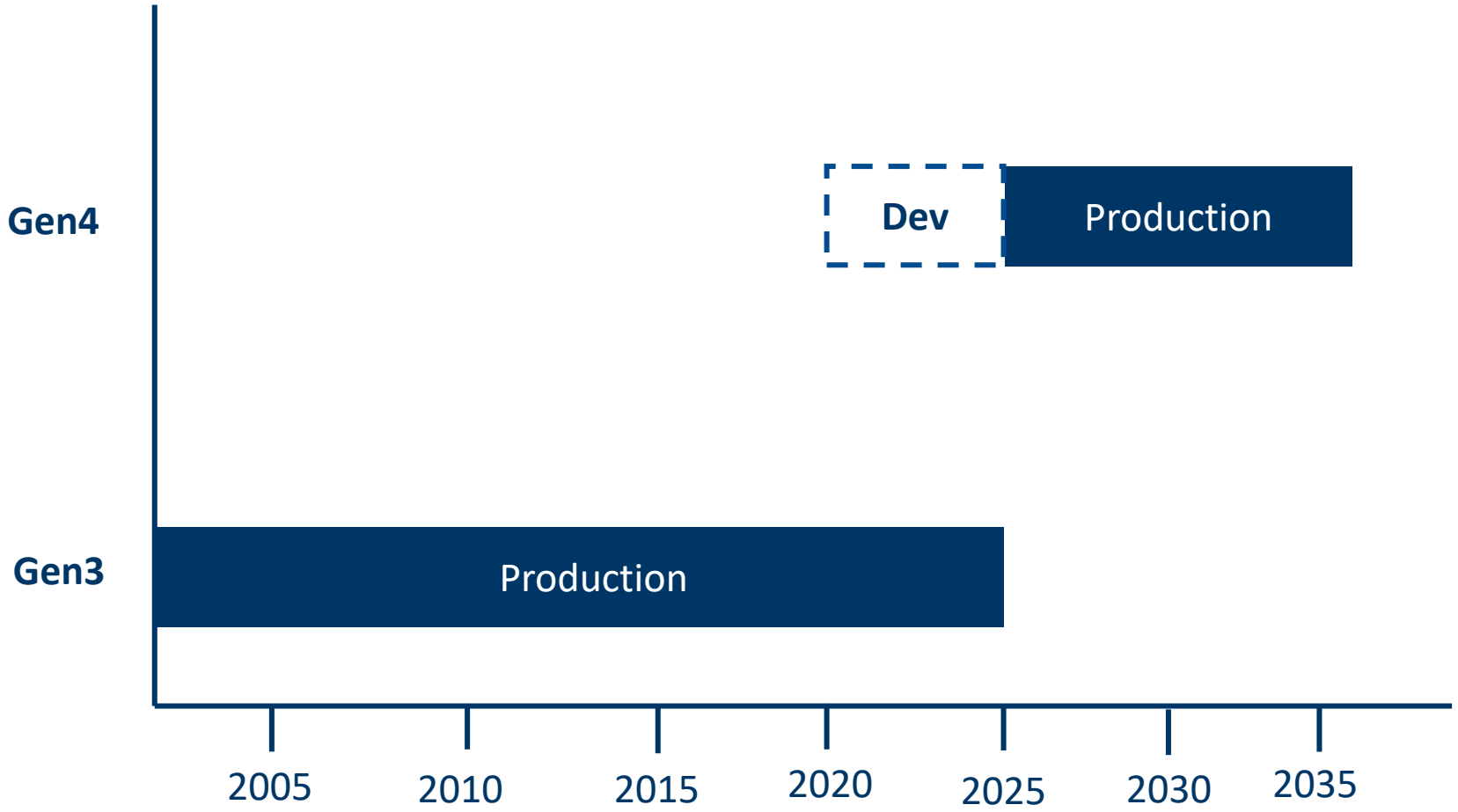
Chip and Hardware shortage

- Newer SoC/SoM/Board aren't available
- Peripheral obsolete (e.g. NAND, NOR flashes)
- Migrate hardware based on existing/available SoC's

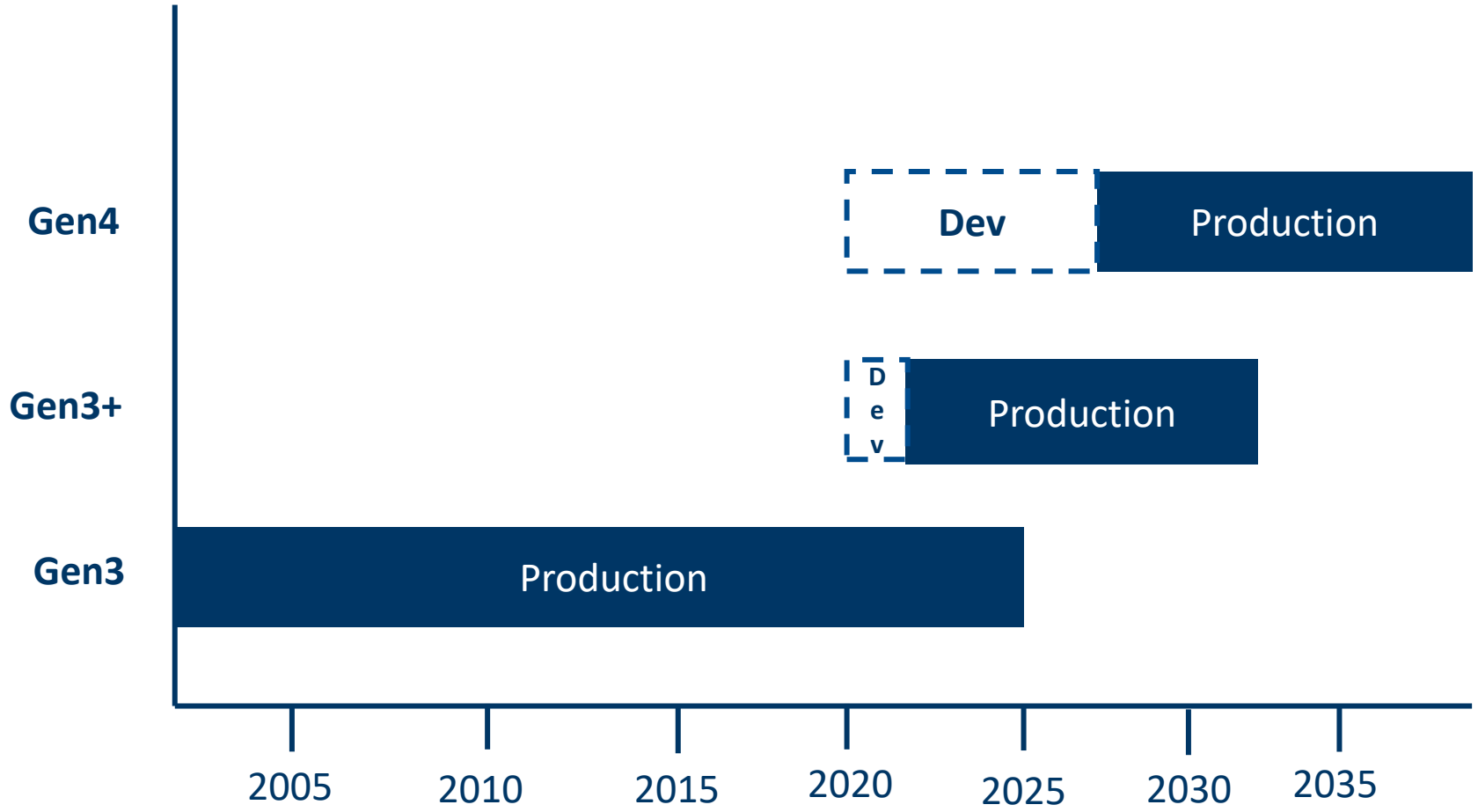
Are we on the same page?

- Is this migration/upgrade valid for my product portfolio?
- How long it will take? Timeline?

Product lifecycle



Modified product lifecycle



Customer cases

- Retain new (Gen4) code base of middleware and application software
- Obsolete connectivity technology (e.g. 3G shutdown)
- Time to market – switching to new family vs retain the same family SoC
  - ✓ Cost – Development, Certification
  - ✓ Production timeline

How to upgrade?

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What can be upgraded? (Gen3 ➡ Gen3+)

- Linux Kernel
- Root filesystem
- Over the Air
  - ✓ New network component
  - ✓ Larger memory
- Bootloader
  - ✓ U-boot

Steps to migrate

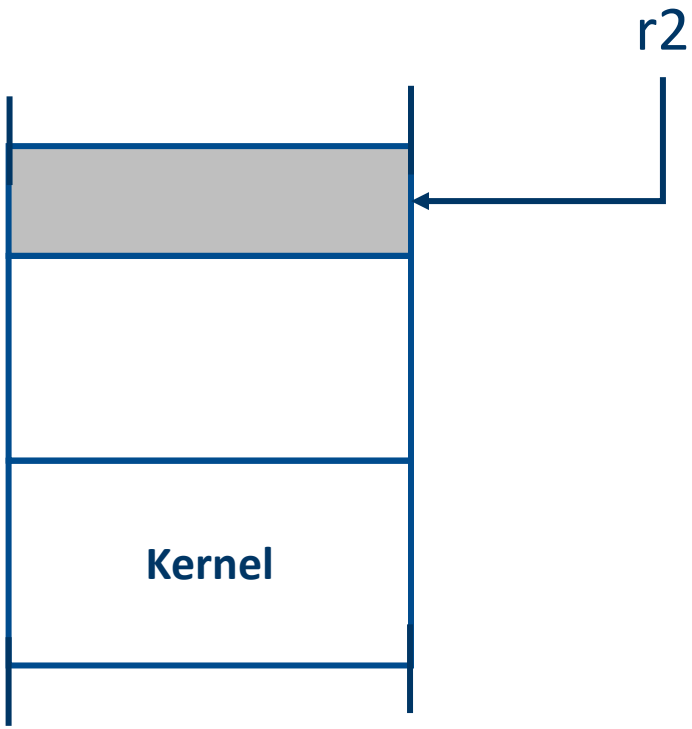
- One step at a time
- Add basic blocks (Clock, Timer, UART) and make it bootable
- Enable only needed features in Kconfig
- Consider out-of-tree modules
- Enable security

Kernel

- Platform identification
- Create devicetree for the board
  - ✓ Less code duplication across platforms
  - ✓ Memory configuration
  - ✓ Device population
- No/very less custom changes when devicetree is used
- Migrate defconfig for the board

Platform type vs Devicetree

- Moving from `MACHINE_START` to `setup_machine_fdt()` to find the `machine_desc[]`



	Machine	DT
r1	Machine type	-
r2	ATAGS	DTB

Platform identification in machine code

```
/*
 * Set of macros to define architecture features.
 * This is built into a table by the linker.
 */
#define MACHINE_START(_type, _name)                     \
static const struct machine_desc __mach_desc_##_type    \
__used                                                   \
__attribute__((__section__(".arch.info.init"))) = {      \
        .name           = _name,

#define MACHINE_END                                 \
};


MACHINE_START(AT91SAM9260_CTEK, "Atmel AT91SAM9260-CTEK")
        /* Maintainer: Atmel */
        .init_time      = at91sam926x_pit_init,
        .map_io         = at91_map_io,
        .handle_irq     = at91_aic_handle_irq,
        .init_early     = ek_init_early,
        .init_irq       = at91_init_irq_default,
        .init_machine   = ek_board_init,
MACHINE_END
```

Devicetree for board

```
+/dts-v1/;
+#include "at91sam9260.dtsi"
+#include <dt-bindings/input/input.h>
+
+/ {
+       model = "CTEK G6200";
+       compatible = "atmel,at91sam9260ctek", "atmel,at91sam9260", "atmel,at91sam9";
+
```

MCU UART (deadbeef)

- UART for custom peripheral

```
static struct platform_device serial_device = {
        .name                   = "serial8250",
        .id                     = 0,
        .dev                    = {
                .platform_data  = serial_platform_data,
        },
};
```

```
/* USART0 on ttyS1. (Rx, Tx, CTS, RTS, DTR, DSR, DCD, RI) */
at91_register_uart(AT91SAM9260_ID_US0, 1, ATMEL_UART_CTS | ATMEL_UART_RTS
                   | ATMEL_UART_DTR | ATMEL_UART_DSR | ATMEL_UART_DCD
                   | ATMEL_UART_RI);

/* USART1 on ttyS2. (Rx, Tx, RTS, CTS) */
at91_register_uart(AT91SAM9260_ID_US1, 2, ATMEL_UART_CTS | ATMEL_UART_RTS);
at91_add_device_serial();
```

Contd.,

```
mcu: serial@fffb0000 {
        compatible = "atmel,at91sam9260-usart";
        reg = <0xfffb0000 0x200>;
        interrupts = <6 IRQ_TYPE_LEVEL_HIGH 5>;
        atmel,use-dma-rx;
        atmel,use-dma-tx;
        pinctrl-names = "default";
        pinctrl-0 = <&pinctrl_usart0>;
        clocks = <&pmc PMC_TYPE_PERIPHERAL 6>;
        clock-names = "usart";
        status = “okay";
};
```

Kernel: Add devicetree

```
From 8dd19e8cc050c37fe105052424e46e4a23423057 Mon Sep 17 00:00:00 2001
From: Parthiban Nallathambi <parthiban@linumiz.com>
Date: Sat, 7 May 2022 13:26:30 +0000
Subject: [PATCH] arm: boot: add device tree for ctek g6200

add initial device tree for ctek g6200 based on at91sam9260
evaluation kit

Signed-off-by: Parthiban Nallathambi <parthiban@linumiz.com>
---
 arch/arm/boot/dts/Makefile               |   1 +
 arch/arm/boot/dts/at91sam9260_g6200.dts | 253 ++++++++++++++++++++++++++++++++
 2 files changed, 254 insertions(+)
 create mode 100644 arch/arm/boot/dts/at91sam9260_g6200.dts

diff --git a/arch/arm/boot/dts/Makefile b/arch/arm/boot/dts/Makefile
index 7e8151681597..9ea40b75cf2e 100644
--- a/arch/arm/boot/dts/Makefile
+++ b/arch/arm/boot/dts/Makefile
@@ -18,6 +18,7 @@ dtb-$(CONFIG_SOC_AT91SAM9) += \
        tny_a9260.dtb \
        usb_a9260.dtb \
        at91sam9260ek.dtb \
+       at91sam9260_g6200.dtb \
        at91sam9261ek.dtb \
        at91sam9263ek.dtb \
        at91-sam9_l9260.dtb \
```

I2C: Userspace driver to IIO

- Removed / Dropped I2C custom driver in userspace
- Moved to Industrial IO

```
&i2c0 {
    #address-cells = <1>;
    #size-cells = <0>;

    light-sensor@60 {
        compatible = "vishay,vcnl4035";
        reg = <0x60>;
        interrupt-parent = <&gpio4>;
        interrupts = <11 IRQ_TYPE_LEVEL_LOW>;
    };
};
```

_defconfig migration

- Review all the features in 5.10 SLTS
- Add basics and append (only) needed features
- Migration step by step
- Storage space limitation and Kernel size
  - ✓ Strip & Compression - lzo

U-Boot

- Porting is very simple, If you have,
  - ✓ SoC support
  - ✓ Support for all IP blocks
  - ✓ Board based on this SoC
- If not,
  - ✓ Custom power sequence
  - ✓ Custom drive handling
- Migration consideration
  - ✓ Kconfig – from header files
  - ✓ Driver model

U-Boot: Board identification mechanism + devicetree

```
int board_late_init(void)
{
        u32 type = get_board_type();

        switch (type) {
                case BOARD_A:
                        env_set("bootconf", "conf@board-a.dtb");
                        break;
                case BOARD_B:
                        env_set("bootconf", "conf@board-b.dtb");
                        break;
                default:
                        printf("Unknown board %d\n", type);
                        break;
        }

        return 0;
}
```

```
bootm ${fit_addr}#${bootconf}
```

U-Boot: Kernel image type

- bootz vs bootm / zImage vs uImage vs fitImage support
- Loading kernel from different storage medium (with different filesystem)

Key factors

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Unexpected deviation

- Software time deviation
- Change of hardware components e.g. NAND
- Porting custom drivers
- Corner cases (Panics and OOPS)

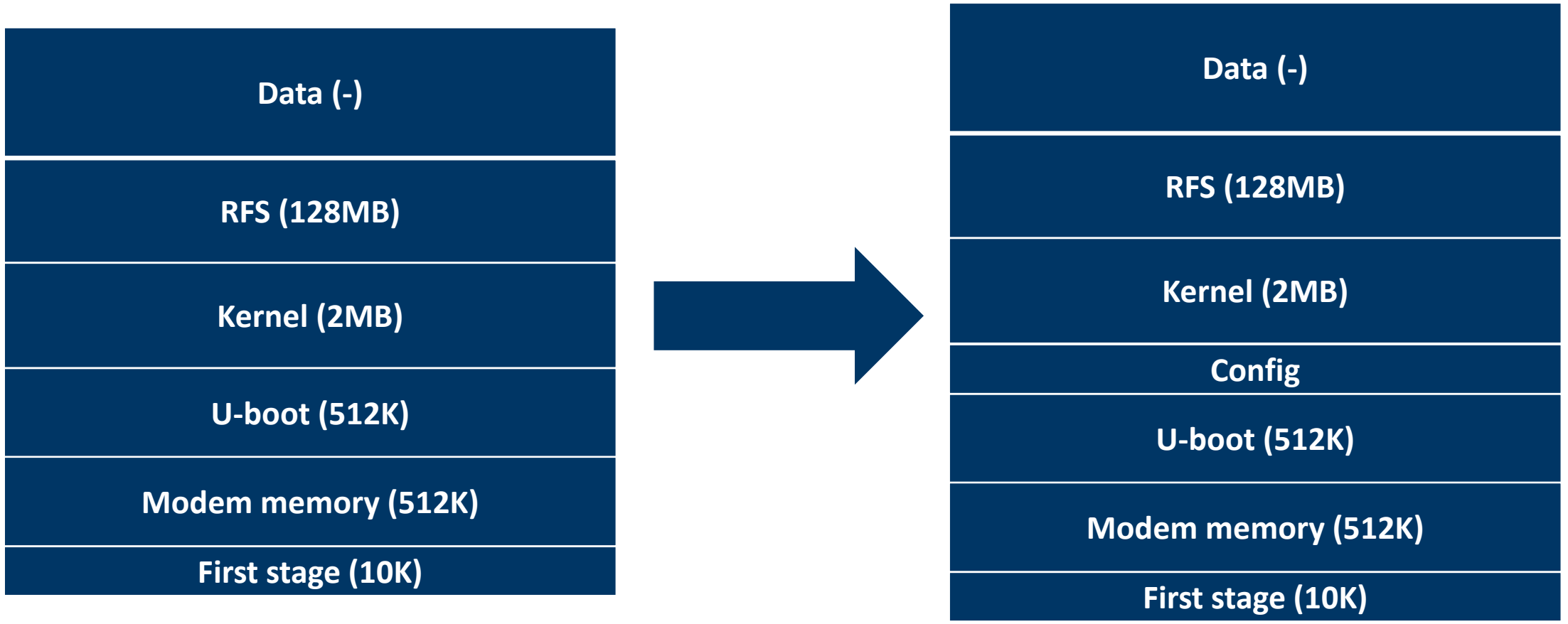
Software time deviation

- Boot time impact
- initramfs
  - ✓ compiling most kernel parts are modules

```
setenv bootargs console=ttyS0,115200 rootfstype=ramfs root=/dev/ram0
```

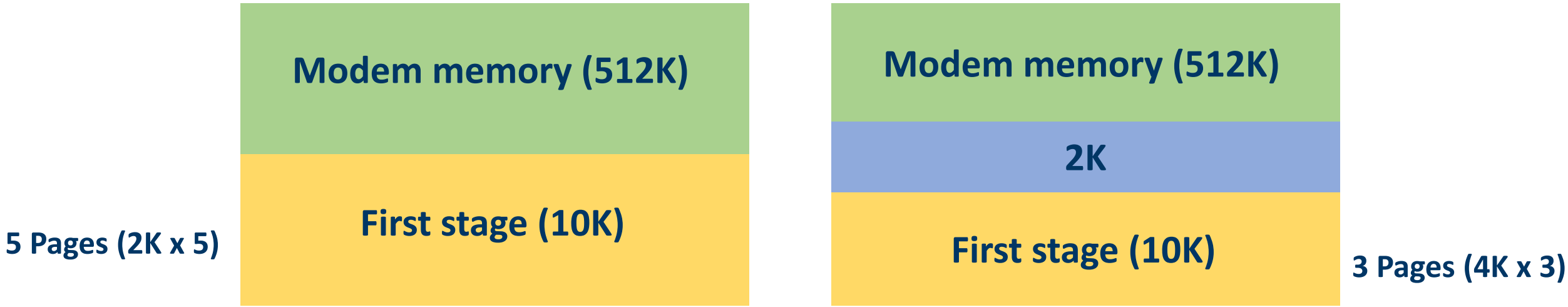
New partition from vendor

```
nand read ${loadaddr} ${new_offset}
setenv bootargs console=ttyS0,115200 ubi.mtd=5 root=ubi:root${ubibootvol}
mtdparts=atmel_nand:10K(bootstrap),512K(modem),512K(U-boot),64K(config),2M(Kernel),128M(RFS),-
(Data) rw rootfstype=ubifs
```



NAND Page size

- Partition size adjustment



Porting custom driver

- Migration effort for compiler compatibility
- Porting to newer API and ABI
  - ✓ Memory reservation for error logging – moved to devicetree without any custom memory reservation in the kernel/driver
  - ✓ Platform device to device tree

Build system

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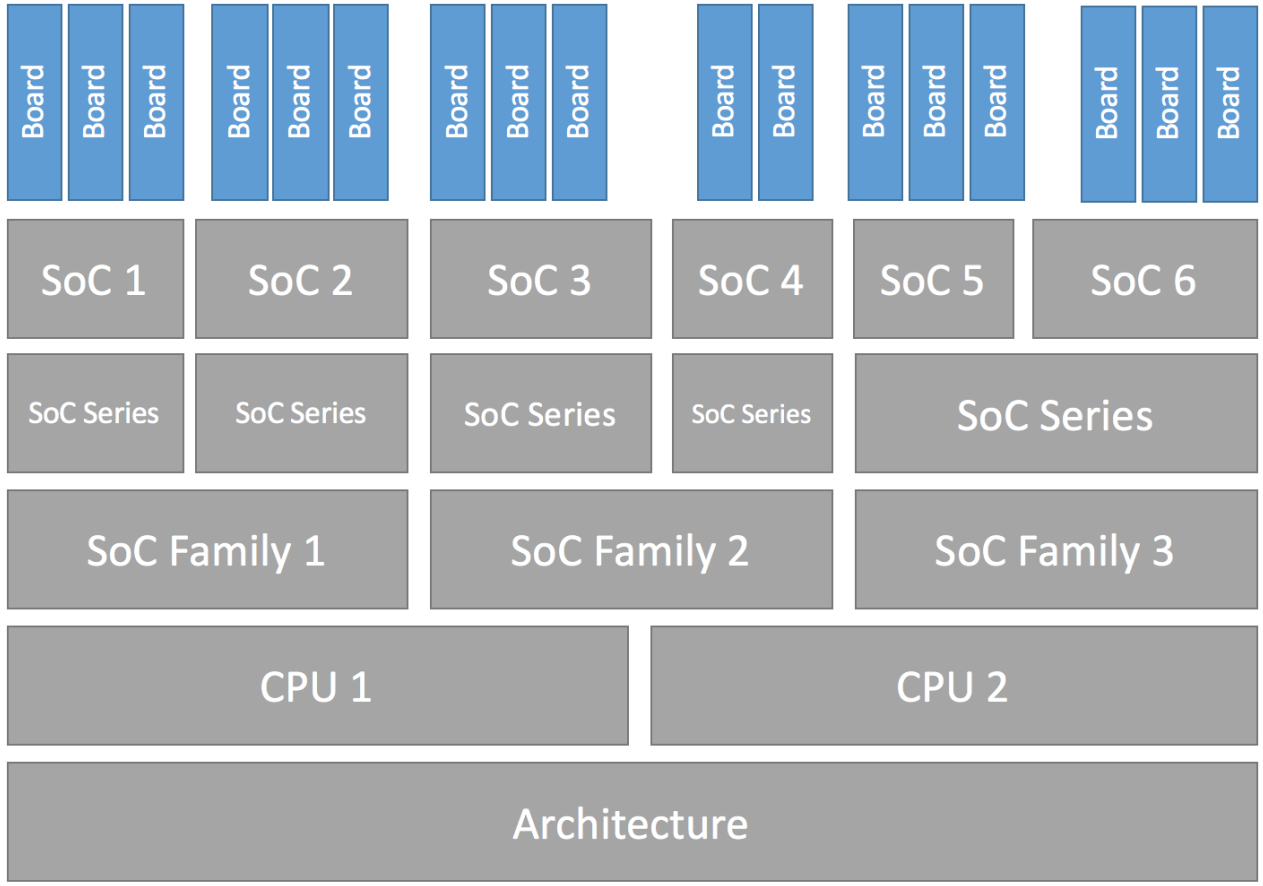
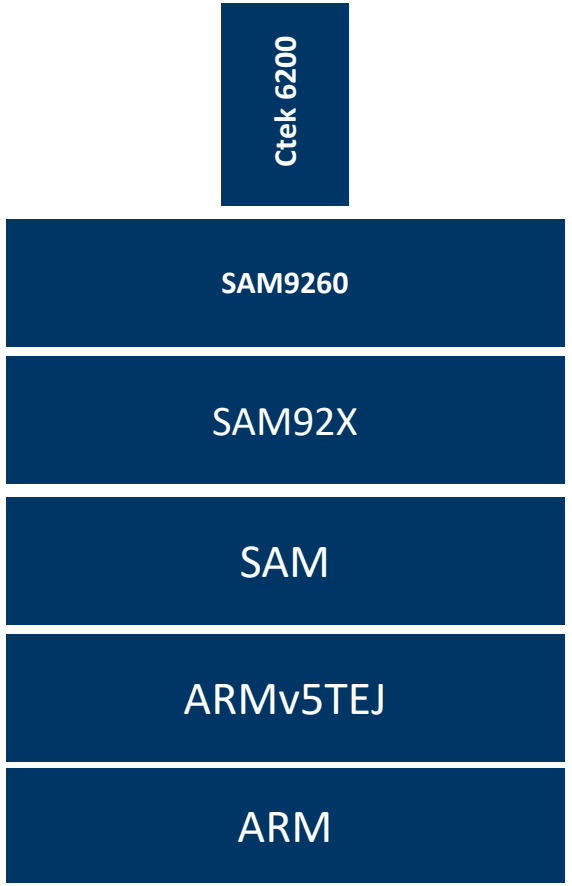
Yocto project : machine conf





Ref: https://docs.zephyrproject.org/latest/_images/hierarchy.png

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Cont.,

```
#@TYPE: Machine
#@Name: CTEK AT91SAM9260 G6200 NAND
#@DESCRIPTION: Machine configuration for CTEK AT91SAM9260
G6200 board

require include/sam9x60.inc

DISTRO_FEATURES_DEFAULT = ""
DISTRO_FEATURES = "ipv4"
DISTRO_FEATURES:remove = "pulseaudio x11 alsa"
BAD_RECOMMENDATIONS += "udev-hwdb"
```

```
# Microchip SAM9X60 defaults
require at91sam9.inc

SOC_FAMILY = "at91sam9:sam9x60"
```

```
# Atmel AT91SAM9 defaults
require conf/machine/include/soc-family.inc
require conf/machine/include/arm/armv5/tune-arm926ejs.inc

SOC_FAMILY = "at91sam9"

SERIAL_CONSOLES ?= "115200;ttyS0"
```

```
DEFAULTTUNE ?= "armv5te"

require conf/machine/include/arm/arch-armv5-dsp.inc

TUNEVALID[arm926ejs] = "Enable arm926ejs specific processor optimizations"
TUNE_CCARGS .= "${@bb.utils.contains('TUNE_FEATURES', arm926ejs , ' -
mcpu=arm926ej-s', '', d)}"
MACHINEOVERRIDES =. "${@bb.utils.contains('TUNE_FEATURES', 'arm926ejs',
'armv5:', '', d)}"

AVAILTUNES += "arm926ejs"
ARMPKGARCH:tune-arm926ejs = "arm926ejs"
```

Benefits

- Benefited with new features (migration)
  - ✓ Power Management: pm_runtime
  - ✓ Distributed Switch Architecture (DSA) with devicetree based device model
  - ✓ Virtualization: Enabled the way to use Embedded Containers like Pantcor/Pantavisor
  - ✓ Over the Air using SWUpdate and RAUC (with Hawkbit)
  - ✓ USB: GadgetFS to ConfigFS with libusbg
  - ✓ squashfs and lifetime of NAND, NOR storage
  - ✓ Overcome 2.6.x CVE's

Reference

[1] Device Tree - https://www.youtube.com/watch?v=Nz6aBffv-Ek

[2] Porting U-Boot and Linux on New ARM Boards -

https://www.youtube.com/watch?v=5E0sdYkvq-Q

Questions?

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